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Cost-effectiveness of rapid diagnosis of drug-resistant tuberculosis

Globally, tuberculosis (TB) is a leading cause of premature death. There are treatments for tuberculosis, but drug-resistant strains of tuberculosis have emerged, mostly due to improper or incomplete treatment. If diagnosed properly in a timely manner, extremely drug-resistant tuberculosis (XDR-TB) can often be successfully treated with a different set of medications. Most importantly, successful and timely treatment are the key to preventing further transmission of DR-TB. Sending a person with XDR-TB home for 3 weeks perpetuates this public health crisis.

Diagnostic Test	Mean cost /sample ($)	Effectiveness (days to XDR diagnosis)	Incremental cost/sample ($US)	Incremental effectiveness	Incremental cost effectiveness ($/day saved)
MODS	$30.04	14.3 days	-----	-----	-----
MGIT	$46.32	24.7 days	$16.28	dominated	dominated
PSQ	$55.50	1.1 days	$25.46	13.2	**$1.93/day saved**
LPA plus and sl	$63.03	1.1 days	$7.53	dominated	dominated

Fig. 1. Incremental cost-effectiveness of diagnostic tests for extremely drug-resistant tuberculosis
LPA = Line-probe assay
MDR-TB = Multi-Drug Resistant Tuberculosis
MGIT = Mycobacteria Growth Indicator Tube
MODS = Microscopic-observation drug-susceptibility assay
PSQ = Pyrosequencing
US = United States
XDR-TB = Extremely-Drug Resistant Tuberculosis
Dominated = test was both faster and less costly than the best prior test.

One barrier to rapid diagnosis and treatment is that standard diagnostic methods in which the mycobacteria are grown and tested for drug-susceptibility, take a full three weeks to produce results. To address this barrier, new, more rapid methods for diagnosing DR-TB have been developed. Although a shorter time to diagnosis is important, there are other factors that must be considered when a healthcare organization selects which test they will use. These factors include the accuracy of the test, the safety hazard profile of the test, and the cost of switching to and performing the test. As part of a larger research project, we analyzed cost-effectiveness information about 4 diagnostic tests for drug-resistant tuberculosis while considering test accuracy, time to diagnosis, and test safety.

The overall study enrolled 1128 participants with confirmed tuberculosis at clinics in India; Moldova; and South Africa in 2012-2013. Saliva samples from each participant were tested for drug-susceptibility the standard growth-based methods (MGIT), 1 alternative growth-based test (MODS),

and 2 molecular assays (pyrosequencing (PSQ), line-probe assay (LPA)). Time to diagnostic result (TTR) was the primary measure of effectiveness. The accuracy of each test was also evaluated with diagnostic sensitivity and specificity. The cost of each test was recorded at each of the three sites and consisted of test-specific laboratory materials, laboratory and medical personnel, and laboratory equipment costs. The difference in costs and effectiveness were calculated for each of the three newer tests in comparison to standard testing using the MGIT process. We also explored which cost components had the greatest influence on the overall cost of each test.

Data from the larger study demonstrated that the new molecular assay tests (LPA and PSQ) returned results in a little over one day, compared with 14 days for the MODS and 24 days for the MGIT growth-based tests. When averaged across all three study sites, the mean cost per sample including equipment and estimated overhead was about $30, $46, $56, and $63 for the MODS, MGIT, PSQ, and LPA, respectively. Overall, the molecular assay tests (PSQ and LPA) were considerably faster than either growth-based test, but also cost more. When comparing the 2 growth-based tests, the MODS was quicker and less costly than MGIT, but may require additional investment to address the safety hazard profile of the MODS in some laboratories. The batch size of samples and personnel costs were the main drivers of cost variation (Fig. 1), suggesting that costs are reduced at laboratories that conduct more tests.

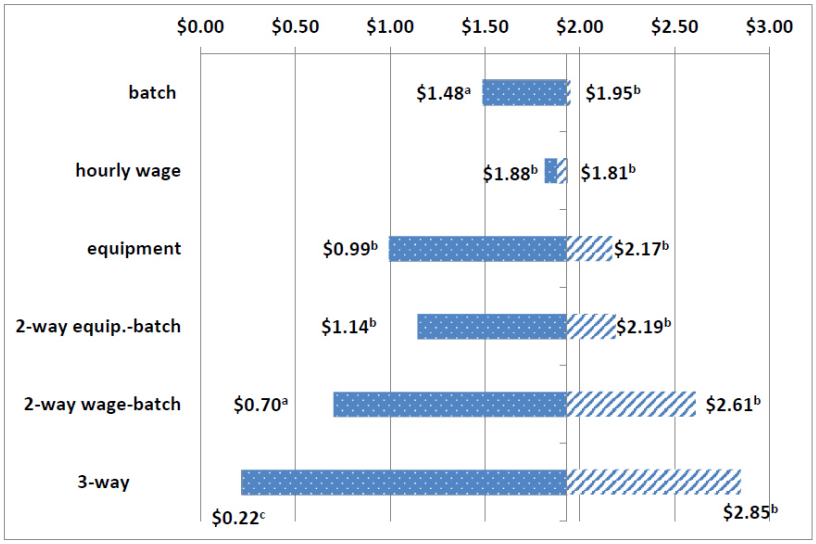

Fig. 2. Sensitivity Analyses varying main components of the ICER
a LPA ICER ratio relative to the optimal choice of MODS
b PSQ ICER ratio relative to the optimal choice of MODS
c MODS ICER ratio relative to the optimal choice of MGIT.

In conclusion, multiple factors must be weighed when selecting a test for the diagnosis of XDR-TB. New, rapid diagnostic tests for XDR-TB can greatly improve the time required to diagnose drug-resistant tuberculosis, potentially improving treatment success, and preventing the spread of XDR-TB. However, many healthcare clinics may operate on small budgets, and cannot readily purchase

new diagnostic technology, even with discounted pricing. Thus, the faster time to result must be weighed against the potential for reduced accuracy and increased costs, while also addressing any safety hazard concerns.

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Publication

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